identifies its own position on the page. Characteristics of the tags are described in more detail below.

Tags are printed in infrared-absorptive ink on any substrate which is infrared-reflective, such as ordinary paper. Near-infrared wavelengths are invisible to the human eye but are easily

5 sensed by a solid-state image sensor with an appropriate filter.

A tag is sensed by an area image sensor in the netpage pen, and the tag data is transmitted to the netpage system via the nearest netpage printer. The pen is wireless and communicates with the netpage printer via a short-range radio link. Tags are sufficiently small and densely arranged that the pen can reliably image at least one tag even on a single click on the page. It is important that the

10 pen recognize the page ID and position on every interaction with the page, since the interaction is stateless. Tags are error-correctably encoded to make them partially tolerant to surface damage.

The netpage page server maintains a unique page instance for each printed netpage, allowing it to maintain a distinct set of user-supplied values for input fields in the page description for each printed netpage.

15 The relationship between the page description, the page instance, and the printed netpage is shown in Figure 4. The printed netpage may be part of a printed netpage document 45. The page instance is associated with both the netpage printer which printed it and, if known, the netpage user who requested it.

As shown in Figure 4, one or more netpages may also be associated with a physical object

20 such as a product item, for example when printed onto the product item's label, packaging, or actual surface.

## 1.2 CODED DATA ON SURFACES USING NETPAGE TAGS

Various netpage coding schemes and patterns are described in the present applicants' co-pending US application USSN 09/575154 entitled "Identity-Coded Surface with Reference Points",

25 filed 23 May 2000; co-pending US application USSN 10/120441 entitled "Cyclic Position Codes", filed 12 April 2002; co-pending US application USSN 10/309358 entitled "Rotationally Symmetric Tags", filed 4 December 2002; co-pending US Application USSN 10/409864 entitled "Orientation-Indicating Cyclic Position Codes", filed 9 April 2003; and co-pending US Application USSN 10/186,631 entitled "Symmetric Tags", filed 4 March 2004 (Docket number NPT037).

30 ### 1.2.1 Tag Data Content

In a preferred form, each tag identifies the region in which it appears, and the location of that tag within the region. A tag may also contain flags which relate to the region as a whole or to the tag. One or more flag bits may, for example, signal a tag sensing device to provide feedback indicative of a function associated with the immediate area of the tag, without the sensing device

35 having to refer to a description of the region. A netpage pen may, for example, illuminate an "active area" LED when in the zone of a hyperlink.

#### 1.2.4.4  Alternative Hexagonal Tag Design 2

Figure 54 shows the logical layout of another alternative hexagonal tag. This tag design is described in detail in the present applicants' co-pending US application USSN

5    10/186,631 entitled "Symmetric Tags" (docket number NPT037US).

Figure 54 shows a logical layout of a hexagonal tag 750 using the tag segment of Figure 46, with one local $2^4$-ary (12,$k$) codeword interleaved with eighteen 3-symbol fragments of eighteen distributed $2^4$-ary (9,$k$) codewords.

In the layout of Figure 54, the twelve 4-bit symbols of the local codeword are

10   -labelled G1 through G12, and are shown with a dashed outline. Each symbol of the eighteen fragments of the eighteen distributed codewords is labelled with an initial prefix of A through F, indicating which of six nominal codewords the symbol belongs to, a subsequent prefix of S through U, indicating which 3-symbol part of the codeword the symbol belongs to, and a suffix of 1 through 3, indicating which of the three possible symbols the symbol is.

15   Tag 750 is structured so that the minimal field of view allows the recovery of the local codeword G of at least one tag, and the entire set of distributed codewords AP through FR via fragments of tags of type P, Q and R included in the field of view. Furthermore, the continuous tiling of tag 750 ensures that there is a codeword available with a known layout for each possible rotational and translational combination (of which there are eighteen). Each distributed codeword

20   includes data which identifies the rotation of the codeword in relation to the tiling, thus allowing the rotation of the tiling with respect to the field of view to be determined from decoded data rather than from other structures, and the local codeword to be decoded at the correct orientation.

Figure 55 shows the logical layout of the hexagonal tag 750 of Figure 54, re-arranged to show the distributed 3-symbol fragments which contribute to the same codewords. For

25   example, if the central tag shown in Figure 54 were a P-type tag, then the six distributed codewords shown in the figure would be the AP, BP, CP, DP, EP and FP codewords. Figure 55 also shows the local G codeword of the tag. Clearly, given the distributed and repeating nature of the distributed codewords, different fragments from the ones shown in the figure can be used to build the corresponding codewords.

30   #### 1.2.4  Tag Image Processing and Decoding

Figure 7 shows a tag image processing and decoding process flow. A raw image 202 of the tag pattern is acquired (at 200), for example via an image sensor such as a CCD image sensor, CMOS image sensor, or a scanning laser and photodiode image sensor. The raw image is then typically enhanced (at 204) to produce an enhanced image 206 with improved contrast and more

35   uniform pixel intensities. Image enhancement may include global or local range expansion, equalisation, and the like. The enhanced image 206 is then typically filtered (at 208) to produce a